Serial No. 09/468,173
Page 2

IN THE SPECIFICATION

Please replace the following paragraphs in the specification with the amended paragraphs as follows:

For the paragraph beginning on page 1, lines 8-10:

a1

This application is also a continuation-in-part of U.S. Patent Application serial number 09/293,535 filed April 15, 1999, now U.S. Patent No. 6,584,153, which is hereby incorporated herein by reference in its entirety.

For the paragraph beginning on page 1, lines 11-14:

a2

This application is also a continuation-in-part of U.S. Patent Application serial number [[__________]] 09/384,394 filed August 27, 1999, ~~entitled "Method and Apparatus for Compressing Video Sequences,"~~ which is hereby incorporated herein by reference in its entirety.

For the paragraph beginning on page 1, lines 15-18:

a3

This application is also a continuation-in-part of U.S. Patent Application serial number 09/428,066 filed October 27, 1999, now U.S. Patent No. 6,651,252, ~~entitled "Method and Apparatus for Transmitting Video and Graphics in a Compressed Form,"~~ which is hereby incorporated herein by reference in its entirety.

For the paragraph beginning on page 7, lines 19-25:

a4

Figure 1 depicts a high-level block diagram of an information distribution system 100, e.g., a video-on-demand system or digital cable system, ~~that~~ which incorporates the present invention. The system 100 contains service provider equipment (SPE) 102 (e.g., a head end), a distribution network 104 (e.g., hybrid fiber-coax network) and subscriber equipment (SE) 106. This form of information distribution system is disclosed in commonly assigned U.S. patent number 6,253,375 ~~application serial number 08/984,710 filed December 3, 1997~~. The system is known as DIVA provided by DIVA Systems Corporation.

For the paragraph beginning on page 7, lines 26-33:

a5

In general, the SPE 102 produces a plurality of digital streams that contain encoded information in MPEG compressed format. These streams are modulated using a modulation format that is compatible with the distribution network 104. The

a5 cont'd.

subscriber equipment 106, at each subscriber location ~~1061, 1062, ,~~ 106_1, 106_2, through 106n, comprises a receiver 124 and a display 126. Upon receiving a stream, the subscriber equipment receiver 124 extracts the information from the received signal and decodes the stream to produce the information on the display, i.e., produce a television program, program guide page, or other multimedia program.

For the paragraph beginning on page 8, lines 1-8:

a6

In an interactive information distribution system such as the one described in commonly assigned U.S. patent number 6,253,375 ~~application 08/984,710, filed December 3, 1997~~, the program streams are addressed to particular subscriber equipment locations that requested the information through an interactive menu. A related interactive menu structure for requesting video on demand is disclosed in commonly assigned U.S. patent ~~application serial~~ number 6,208,335 ~~08/984,427, filed December 3, 1997~~. Another example of interactive menu for requesting multimedia services is the interactive program guide (IPG) disclosed in commonly assigned U.S. patent application 60/093,891, filed in July 23, 1998.

For the paragraph beginning on page 8, lines 15-24:

a7

The invention produces the IPG using a compositing technique that is described in commonly assigned US patent number 6,415,437 and US patent application serial ~~numbers 09/201,528 filed November 30, 1998 and~~ ______ number 09/359,561, filed July 22 ~~23~~, 1999 ~~(attny dockets 168 and 168 CIP1)~~, which are hereby incorporated by reference herein. The compositing technique, which will not be discussed further herein, enables full motion video to be positioned within an IPG and have the video seamlessly transition from one IPG page to another. The composited IPG pages (i.e., a plurality of video frame sequences) are coupled from a video source 114 to an encoding and multiplexing unit 116 of the present invention. Audio signals associated with the video sequences are supplied by an audio source 112 to the encoding and multiplexing unit 116.

For the paragraph beginning on page 9, lines 6-21:

a8

Figure 2 depicts a block diagram of the encoding and multiplexing unit 116 of Figure 1 which produces a transport stream comprising a plurality of encoded video, audio, and data elementary streams. The invented system is designed specifically to

a8 cont'd.

work in an ensemble encoding environment, where a plurality of video streams are generated to compress video information that carries common and non-common content. Ideally, the common content is encoded into a single elementary stream and the non-common content are encoded into separate elementary streams. However, in a practical MPEG encoding process, some common information will appear in the stream intended to carry non-common information and some non-common information will appear in the stream intended to carry common information. In this way, ~~thecommon~~ the common content is not duplicated ~~notduplicated~~ in every stream, yielding significant bandwidth savings. Although the following description of the invention is presented within the context of IPG, it is important to note that the method and apparatus of the invention is equally applicable to a broad range of applications, such as broadcast video on demand delivery, e-commerce, internet video education services, and the like, where delivery of video sequences with command content is required.

For the paragraph beginning on page 13, lines 24-32:

a9

A transport stream, as defined in ISO standard 13818-1 (commonly known as MPEG-2 systems specification), is a sequence of equal sized packets, each 188 bytes in length. Each packet has a 4 byte ~~bytes of~~ header and 184 bytes of data. The header contains a number of fields, including a PID field. The PID field contains thirteen bits and uniquely identifies each packet that contains a portion of a "stream" of video information as well as audio information and data. As such, to decode a particular video stream (or audio or data stream) for viewing or presentation, the decoder in the subscriber or user equipment extracts packets containing a particular PID and decodes those packets to create the video (or audio or data) for viewing or presenting.

For the paragraph beginning on page 21, line 31 to page 22, line 15:

a10

To illustrate the applicability of the invention to encoding IPG sequences, Figures 9 and 10 depict a frame from two different sequences of IPG pages 900 and 1000. The common information is everything except the programming grid 902 and 1002. The non-common information is the programming grid 902 and 1002. The programming grid 902 and 1002 changes from sequence 900 to sequence 1000. This grid changes for each channel group and each time

interval. The IPG display 900 of Figure 9 comprises a first 905A, second 905B and third 905C time slot objects, a plurality of channel content objects 910-1 through 910-8, a pair of channel indicator icons 941A, 941B, a video barker 920 (and associated audio barker), a cable system or provider logo 915, a program description region 950, a day of the week identification object 931, a time of day object 939, a next time slot icon 934, a temporal increment/decrement object 932, a "favorites" filter object 935, a "movies" filter object 936, a "kids" (i.e., juvenile) programming filter icon 937, a "sports" programming filter object 938 and a VOD programming icon 933. It should be noted that the day of the week object 931 and next time slot icon 934 may comprise independent objects (as depicted in Figure 9) or may be considered together as parts of a combined object. Details regarding the operation of the IPG pages, their interaction with one another and with a user are described in commonly assigned US patent application 09/359,560, [[______________]] filed July 22 ~~23~~, 1999, ~~(attorney docket no. 070 CIP2)~~ which is hereby incorporated herein by reference.

a10 cont'd.

For the paragraph beginning on page 27, lines 12-15:

a11

Details regarding the operation of the IPG page of Figure 9, the interaction of this page with other pages and with a user are described in commonly assigned US patent application 09/359,560, [[______________]] filed July 22 ~~23~~, 1999 ~~(attorney docket no. 070 CIP2) which is hereby incorporated herein by reference~~.

For the paragraph beginning on page 27, line 26 to page 28, line 7:

a12

The HEE 1302 produces a plurality of digital streams that contain encoded information in illustratively MPEG-2 compressed format. These streams are modulated using a modulation technique that is compatible with a communications channel 1330 that couples the HEE 1302 to one or more LNE (in Figure 1, only one LNE 1328 is depicted). The LNE 1328 is illustratively geographically distant from the HEE 1302. The LNE 1328 selects data for subscribers in the LNE's neighborhood and remodulates the selected data in a format that is compatible with distribution network 1304. Although the system 1300 is depicted as having the HEE 1302 and LNE 1328 as separate components, those skilled in the art will realize that the functions of the LNE may be easily incorporated into the HEE 1302. It is also important to note that the presented slice-based encoding method is not constrained to physical location of any of

a12 con'd

the components. The subscriber equipment (SE) 1306, at each subscriber location ~~13061, 13062, □,~~ 1306_1, 1306_2, through 1306n, comprises a receiver 1324 and a display 1326. Upon receiving a stream, the subscriber equipment receiver 1324 extracts the information from the received signal and decodes the stream to produce the information on the display, i.e., produce a television program, IPG page, or other multimedia program.

For the paragraph beginning on page 28, lines 8-15:

a13

In an interactive information distribution system such as the one described in commonly assigned U.S. patent 6,253,375 ~~application 08/984,710, filed December 3, 1997~~, the program streams are addressed to particular subscriber equipment locations that requested the information through an interactive menu. A related interactive menu structure for requesting video-on-demand is disclosed in commonly assigned U.S. patent 6,208,335 ~~application serial number 08/984,427, filed December 3, 1997~~. Another example of interactive menu for requesting multimedia services is the interactive program guide (IPG) disclosed in commonly assigned U.S. patent application 60/093,891, filed in July 23, 1998.

For the paragraph beginning on page 30, lines 25-31:

a14

The video sequence is coupled to a real time video encoder 1410. The video encoder 1410 then forms a slice based bitstream, e.g., an MPEG-2 compliant bit stream, for the video portion of an IPG. For purposes of this discussion, it is assumed that the GOP structure consists of an I-picture followed by ten B-pictures, where a P-picture separates each group of two B-pictures (i.e., "I-B-B-P-B-B-P-B-B-P-B-B-P-B-B"), however, any GOP structure and size may be used in different configurations and applications.

For the paragraph beginning on page 31, lines 8-15:

a15

The graphics portion of the IPG is separately encoded in the graphics processor 1402. The processor 1402 is supplied guide data from the guide data source (1332 in Figure 2). Illustratively, the guide data is in a conventional database format containing program title, presentation date, presentation time, program descriptive information and the like. The guide data grid generator [[414]] 1414 formats the guide data into a "grid", e.g., having a vertical axis of program sources and a horizontal axis of time increments.

a15 cont'd.

One specific embodiment of the guide grid is depicted and discussed in detail above with respect to Figure 9.

For the paragraph beginning on page 31, line 30 to page 32, line 9:

a16

FIG. 15 depicts a block diagram of the LNE 1328. The LNE 1328 comprises a cable modem 1500, slice combiner 1502, a multiplexer [[504]] 1504 and a digital video modulator 1506. The LNE 1328 is coupled illustratively via the cable modem to the HEE 1302 and receives a transport stream containing the encoded video information and the encoded guide data grid information. The cable modem 1500 demodulates the signal from the HEE 1302 and extracts the MPEG slice information from the received signal. The slice combiner 1502 combines the received video slices with the guide data slices in the order in which the decoder at receiver side can easily decode without further slice re-organization. The resultant combined slices are PID assigned and formed into an illustratively MPEG compliant transport stream(s) by multiplexer 1504. The slice-combiner (scanner) and multiplexer operation is discussed in detail with respect to Figures 15-20. The transport stream is transmitted via a digital video modulator 506 to the distribution network 1304.

For the paragraph beginning on page 33, line 4 to page 34, line 2:

a17

Figure 17 depicts a process 1700 that is used to form a bitstream 1710 containing all the intra-coded slices encoded at a particular time t1 of Figure 16. At step 1702, a plurality of IPG pages 1702_1 ~~17021~~ through 1702_{10} ~~170210~~ are provided to the encoding unit. At step 1704, each page is slice base encoded to form, for example, guide portion slices g1/s1 through g1/sN and video portion slices v/s1 through v/sN for IPG page 1 1704_1 ~~17041~~.

_____The slice based encoding process for video and guide portions can be performed in different forms. For example, guide portion slices can be pre-encoded by a software MPEG-2 encoder or encoded by the same encoder as utilized for encoding the video portion. If the same encoder is employed, the parameters of the encoding process is adjusted dynamically for both portions. It is important to note that regardless of the encoder selection and parameter adjustment, each portion is encoded independently. While encoding the video portion, the encoding is performed by assuming the full frame size (covering both guide and video portions) and the guide portion of the full frame is padded with null data. This step, step 1704, is performed at

the HEE. At step 1706, the encoded video and guide portion slices are sent to the LNE. If the LNE functionality is implemented as part of the HEE, then, the slices are delivered to the LNE as packetized elementary stream format or any similar format as output of the video encoders. If LNE is implemented as a remote network equipment, the encoded slices are formatted in a form to be delivered over a network via a preferred method such as cable modem protocol or any other preferred method. Once the slice-based streams are available in the LNE, the slice combiner at step 1706 orders the slices in a form suitable for the decoding method at the receiver equipment.

a17 cont'd.

_____As depicted in Figure 17 (b), the guide portion and video portion slices are ordered in a manner as if the original pictures in Figure 17 (a) are scanned from left to right and top to bottom order. Each of the slice packets are then assigned PID's as discussed in Figure 16 by the multiplexer; PID1 is assigned to g1/s1 … g1/sn, PID2 to g2/s1 … g2/sn, ..., PID10 to g10/s1 … g10/sn, and PID11 is assigned to v/s1 … v/sn. The resultant transport stream containing the intra-coded slices of video and guide portions is illustrated in Figure 17 (c). Note that based on this transport stream structure, a receiving terminal as discussed in later parts of this description of the invention, retrieves the original picture by constructing the video frames row-by-row, first retrieving, assuming PID1 is desired, e.g., g1/s1 of PID1 then v/s1 of PID11, next g1/s2 of PID1 then v/s2 of PID11 and so on.

For the paragraph beginning on page 34, lines 3-33:

Figure 18 illustrates a process 1800 for producing a bitstream 1808 containing the slices from the predictive-coded pictures accompanying the transport stream generation process discussed in Figure 17 for intra-coded slices. As shown in Figure 16, illustratively, only the predicted slices belonging to IPG page 1 is delivered. Following the same arguments of encoding process in Figure 17, at step 1802, the predictive-coded slices are generated at the HEE independently and then forwarded to an LNE either as local or in a remote network location.

a18

_____At step 1804, slices in the predictive-coded guide and video portion slices, illustratively from time periods t2 to t15, are scanned from left to right and top to bottom in slice-combiner and complete data is assigned PID 11 by the multiplexer. Note that the guide portion slices g1/s1 to g1/sn at each time period t2 to t15 does not change from their intra-coded corresponding values at t1. Therefore, these slices are coded as skipped macroblocks "sK". Conventional encoder systems do not necessarily skip

macroblocks in a region even when there is no change from picture to picture. In order to provide this functionality, the encoder is given the parameters for discussed slices to skip macroblocks without any further encoding evaluations. At step 1806, the slice packets are ordered into a portion of final transport stream, first including the video slice packets v2/s1 ... v2/SN to v15/s1 ... v15/sN, then including the skipped guide slices sK/s1 ... sK/sN from t2 to t15 in the final transport stream.

a18 cont'd

______FIG. 19 depicts a complete MPEG compliant transport stream 1900 that contains the complete information needed by a decoder to recreate IPG pages that are encoded in accordance with the invention. The transport stream 1900 comprises the intra-coded bitstream 1710 of the guide and video slices (PIDs 1 to 11), a plurality of audio packets 1902 identified by an audio PID, and the bitstream 1806 containing the predictive-coded slices in PID11. The rate of audio packet insertion between video packets is decided based on the audio and video sampling ratios. For example, if audio is digitally sampled as one tenth of video signal, then an audio packet may be introduced into the transport stream every ten video packets. The transport stream 1900 may also contain, illustratively after every 64 packets, data packets that carry to the set top terminal overlay updates, raw data, HTML, java, URL, instructions to load other applications, user interaction routines, and the like. The data PIDs are assigned to different set of data packets related to guide portion slice sets and also video portion slice sets.

For the paragraph beginning on page 39, line 12 to page 40, line 10:

a19

After the signal is tuned and demodulated, the video streams are recombined via stream processing routine 2402 to form the video sequences that were originally compressed. The processing unit 2402 employs a variety of methods to recombine the slice-based streams, including, using PID filter 2404, demultiplexer 2430, as discussed in the next sections of this disclosure of the invention. Note that the PID filter implemented illustratively as part of the demodulator is utilized to filter the undesired PIDs and retrieve the desired PIDs from the transport stream. The packets to be extracted and decoded to form a particular IPG are identified by a PID mapping table (PMT) 2477.

______After the stream processing unit 2402 has processed the streams into the correct order (assuming the correct order was not produced in the LNE), the slicesare sent to the MPEG decoder 2450 to generate the original uncompressed IPG pages. If

an exemplary transport stream with two PIDs as discussed in previous parts of the this disclosure, excluding data and audio streams, is received, then the purpose of the stream processing unit 2402 is to recombine the intra-coded slices with their corresponding predictive-coded slices in the correct order before the recombined streams are coupled to the video decoder. This complete process is implemented as software or hardware. In the illustrated IPG page slice structure, only one slice is assigned per row and each row is divided into two portions, therefore, each slice is divided into guide portion and video portion.

a19 cont'd.

In order for the receiving terminal to reconstruct the original video frames, one method is to construct a first row from its two slices in the correct order by retrieving two corresponding slices from the transport stream, then construct a second row from its two slices, and so on. For this purpose, a receiver is required to process two PIDs in a time period. The PID filter can be programmed to pass two desired PIDs and filter out the undesired PIDs. The desired PIDs are identified by the controller 2470 after the user selects an IPG page to review. A PID mapping table (2477 of Figure 24) is accessed by the controller 2470 to identify which PIDS are associated with the desired IPG. If a PID filter is available in the receiver terminal, then it is utilized to receive two PIDs containing slices for guide and video portions. The demultiplexer then extracts packets from these two PIDs and couples the packets to the video decoder in the order in which they arrived. If the receiver does not have an optional PID filter, then the demultiplexer performs the two PID filtering and extracting functions. Depending on the preferred receiver implementation, the following methods are provided in Figures 25-28 to recombine and decode slice-based streams.

For the paragraph beginning on page 49, lines 17-23:

a20

In this example, the video PID is one of ten PIDs, the audio PID is the same for each program, and the data PID is one of ten PIDs. In particular, program 1 3001 is assigned video PID 1, the audio PID, and data PID 1. Program 2 3002 is assigned video PID 2, the audio PID, and data PID 2[[. And so on]]<u>, and so forth</u>, until Program 10 3010 is assigned video PID 10, the audio PID, and data PID 10. Note that although the audio PID is referenced for every program, the audio packets are multiplexed into the final transport stream 2918 only once.

For the paragraph beginning on page 51, lines 17-22:

a21

The intra-coded packets 3508 for the first FTS 3502 includes video/audio packet groups 3509. Each of these groups 3509 include, in this example, ten video packets with PIDs 1-3 and an audio packet with the audio PID. For example, 64 video/audio packet groups 3509 may be serially included in the first FTS 3502, followed by a group of data packets with PIDs 1-3. ~~the~~The group of data packets are followed by the predictive-coded packets 3510.

For the paragraph beginning on page 51, lines 23-28:

a22

Similarly, the intra-coded packets 3512 for the second FTS 3504 includes video/audio packet groups 3513. Each of these groups 3513 include, in this example, ten video packets with PIDs 4-6 and an audio packet with the audio PID. For example, 64 video/audio packet groups 3513 may be serially included in the second FTS 3504, followed by a group of data packets with PIDs 4-6. ~~the~~The group of data packets are followed by the predictive-coded packets 3514.

For the paragraph beginning on page 59, lines 9-12:

a23

The first step 4422 involves choosing a largest prime number which is less than or equal to the number of lookahead data PIDs available. In this example, the ~~the~~ number of lookahead data PIDs available is 128, so the prime number within that constraint is 127.

For the paragraph beginning on page 59, lines 13-17:

a24

The second step 4422 involves assigning a data PID to each video PID. This is done by taking the video PID number and modulating it by the prime number. Equivalently, the video PID number is divided by the prime number and the remainder of that division is the data PID number assigned. For example, if the video PID number is 260, the data PID number assigned is 6 (i.e., 260 modulo 127=6).